

## TWO NEW SPECIES OF *CENTROLENELLA* FROM BOLIVIA (ANURA: CENTROLENIDAE)

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*Abstract.*—Two new species of glass-frogs, *Centrolenella bejaranoi* and *C. bergeri*, are described from the cloud forest of the Amazonian slopes of Bolivia. One species is allied to the *C. fleischmanni* group; the other is apparently a member of the *C. prosoblepon* group. This is the first record of the family Centrolenidae from Bolivia.

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A recent checklist (Duellman, 1977) of the centrolenid frogs shows that they are present in most countries in South America; notable exceptions are Chile, Paraguay, Uruguay, and Bolivia. The apparent absence of these glass-frogs from Bolivia is surprising, because the *yungas* region of the Amazonian slopes certainly offers suitable habitat, and *Centrolenella* are known from southern Perú (Duellman, 1976). In fact, the absence of Bolivian *Centrolenella* is an artifact of collections; two recently discovered glass-frogs are described in this paper.

In January 1979, Thomas J. Berger and I collected in the *yungas* of the Chapare region, northeast of Cochabamba, Bolivia (Fig. 1). From the city of Cochabamba (2,600 m) the road winds northeasterly to a pass (3,370 m, km 40.5) and descends through the town of Colomi (3,240 m, km 47.7) in the drainage of the Río Corani. At about 3,000 m the upper edge of the pristine forest is reached; tree ferns and viney bamboo are present. The road heads east and enters the drainage of the Río Santa Isabel. The cloud forest on the upper slopes of the valley is virtually uncut (Fig. 2); numerous streams drain the slopes.

There is a short tunnel through the mountainside at km 86.8, 1,950 m. From km 101 to km 122 the road descends rapidly from 1,950 m to 860 m. The small village of Villa Tunari is at km 160 (300 m). One of our collection sites was a tiny rivulet at km 102, 1,980 m, 15.2 km NE (downhill) of the tunnel. Alternatively, the locality can be described as 58.1 km SW Villa Tunari. Our efforts yielded a small collection of frogs, including two new species of *Centrolenella*. This is the first record of the family Centrolenidae from Bolivia.

*Methods.*—In the following descriptions, the diagnoses follow the format of Lynch and Duellman (1973). The webbing formulae are described as in Savage and Heyer (1967); snout-vent length is abbreviated SVL. For specimen comparisons I have examined the material in The University of Kansas

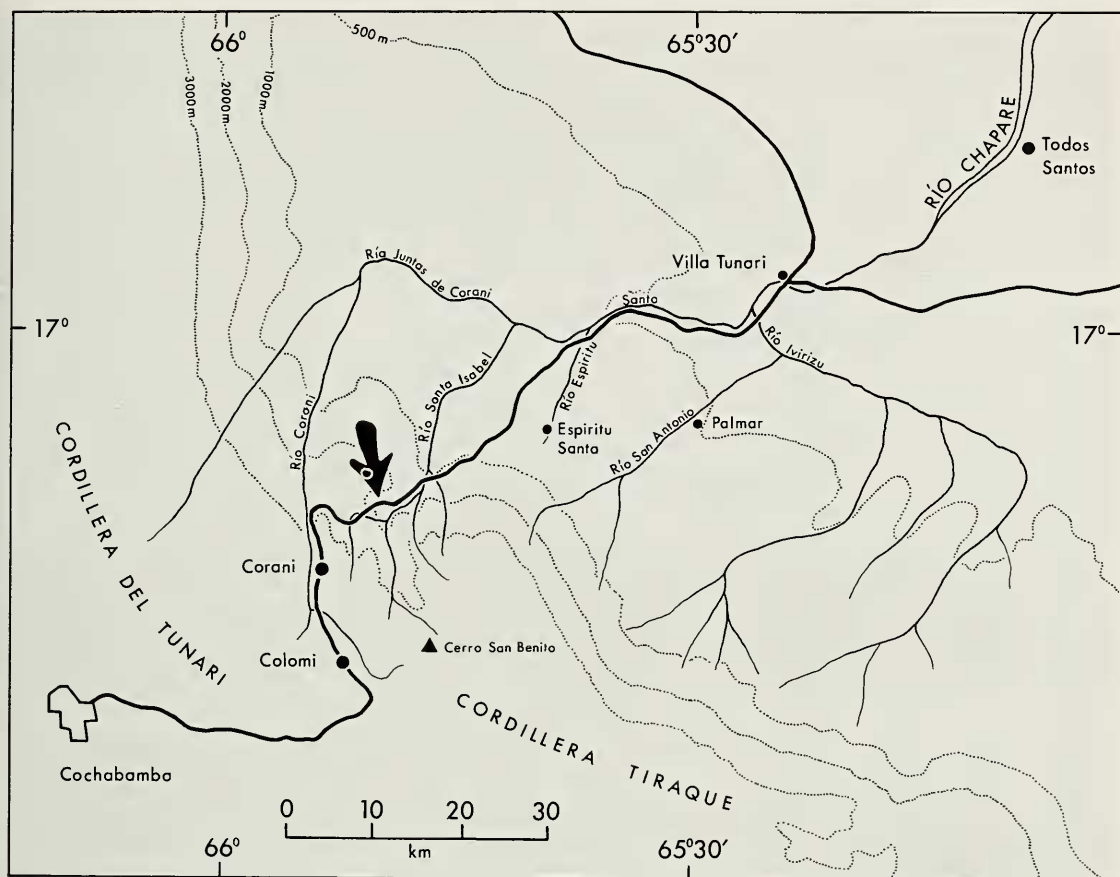


Fig. 1. Map indicating type locality (arrow) of *Centrolenella begeri* and *Centrolenella bejaranoi*, 58.1 km SW Villa Tunari (by road), 1,980 m, Departamento Cochabamba, Bolivia.

Museum of Natural History (KU) listed by Lynch and Duellman (1973) and Duellman (1976). Color notes from life are taken from the field notes of William E. Duellman and the author. The color of the peritoneum in preserved specimens was determined by cutting into the abdomen and recording from direct observation. Fig. 1 was redrawn from Mapa de Bolivia, 1:1,000,000, 1973, Instituto Geográfico Militar, Bolivia.

*Centrolenella bejaranoi*, new species

Fig. 3

*Holotype*.—KU 182369, adult male, 23.8 mm SVL, from 58.1 km SW Villa Tunari (by road), 1,980 m, Departamento Cochabamba, Bolivia (65°50'W, 17°11'S), obtained 21 January 1979, by Thomas J. Berger and David C. Cannatella.

*Paratypes*.—KU 182370-1, same data as the holotype.

*Diagnosis*.—1) Prevomerine teeth absent; 2) bones pale green in life; 3) parietal peritoneum mostly clear, the portion immediately ventral to the

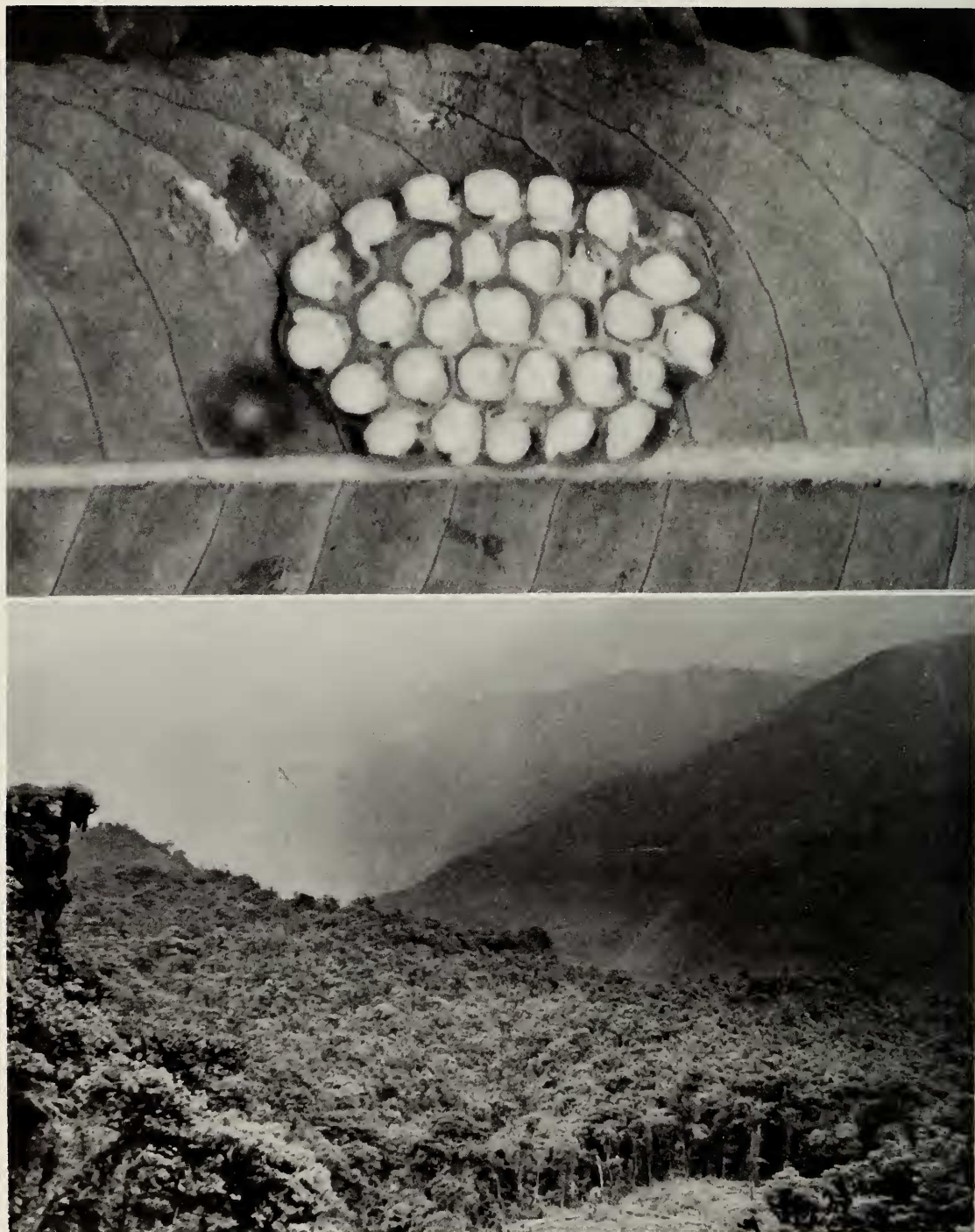


Fig. 2. **Top:** Egg clutch of *C. bergeri*, KU 182372; horizontal diameter approximately 25 mm. **Bottom:** View of cloud forest at type locality.

heart white; pericardial peritoneum ventral to the heart white; visceral peritoneum clear; 4) color in life dark green with minute off-white spots on dorsal surfaces; in preservative, lavender with minute white spots; 5) webbing formula of fingers III(3—3-)IV; 6) webbing formula of toes I(2—

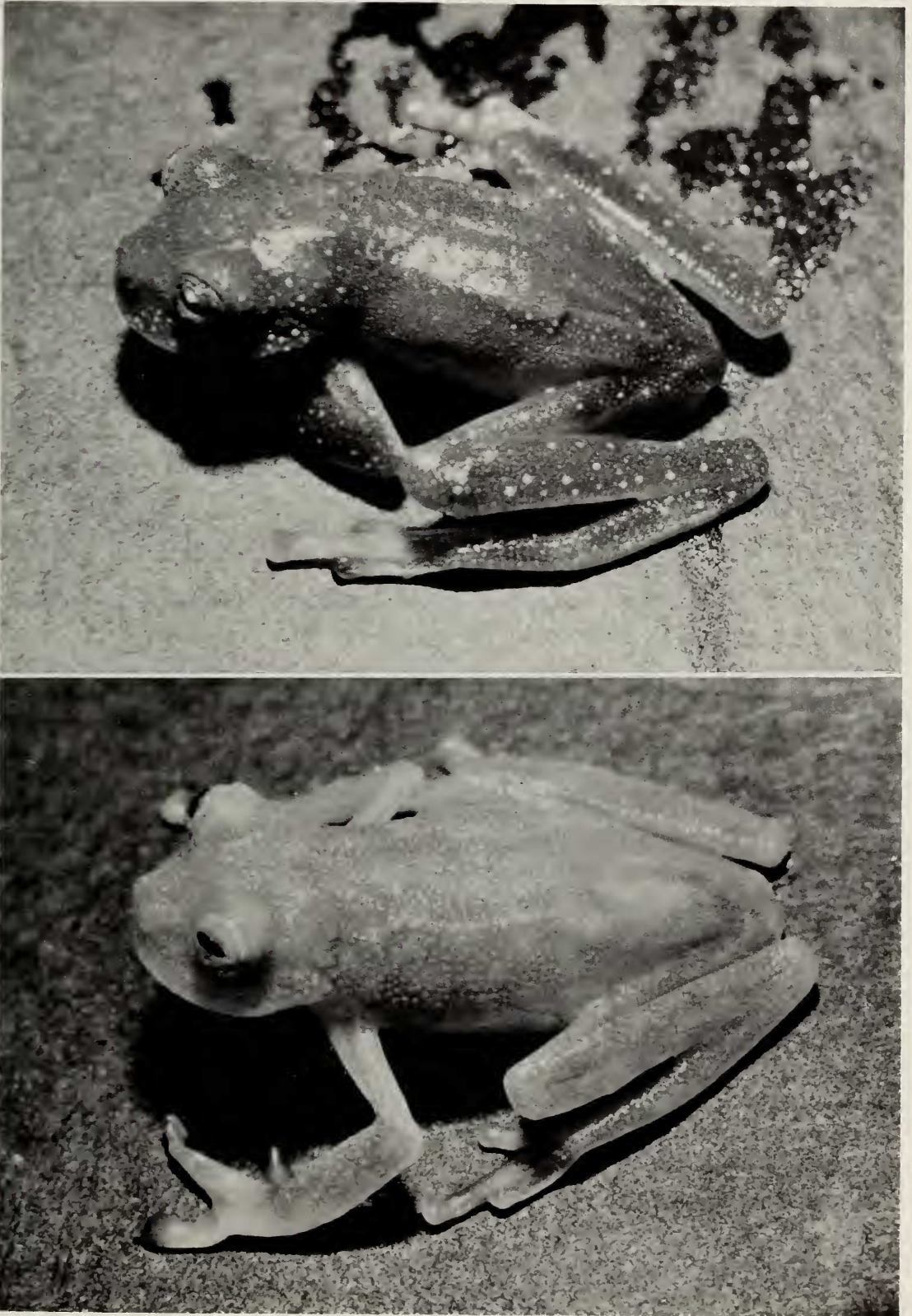


Fig. 3. **Top:** *Centrolenella bejaranoi*, male, paratype, KU 182370, SVL 24.4 mm. **Bottom:** *Centrolenella bergeri*, male, paratype, KU 182364, SVL 23.8 mm.

2.5)II(1.25—2.5)III(1.25—2.5)IV(2.5—1.5)V; 7) snout round in dorsal view; subtruncate in lateral profile; 8) dorsal skin spiculate; 9) forearm and tarsus lacking conspicuous dermal folds; 10) humeral spine absent in males; 11) lower three-fourths of tympanum visible, oriented dorsolaterally, with slight posterior inclination.

The presence of a spiculate dorsum which is lavender in preservative distinguishes this species from most other Andean species of *Centrolenella*. *Centrolenella buckleyi*, *C. spiculata*, *C. truebae*, and *C. johnelsi* have spicules on the dorsal surfaces. The much larger *C. buckleyi* differs by having humeral spines in the males and lacking white spots; *C. truebae* differs by having dark flecks on the dorsum and a denser arrangement of spicules than *C. bejaranoi*. *Centrolenella spiculata* is similar to *C. bejaranoi* in the general appearance and density of spicules, but has prevomerine teeth and much more extensive webbing. The spicules of *Centrolenella bejaranoi* are heterogenous in size; those of *C. buckleyi*, *C. truebae*, and *C. spiculata* are rather homogenous in size.

Cochran and Goin (1970) described *Centrolenella johnelsi* from a single male specimen from Medellin, Colombia. I have not examined specimens of *C. johnelsi*, but have relied on the description and also notes on the holotype provided by William E. Duellman for the following comparisons: *Centrolenella bejaranoi* and *C. johnelsi* have spiculate dorsa and lack prevomerine teeth. However, *C. johnelsi* is a much larger frog (29.3 mm vs. 23.8–24.4 mm in males) than *C. bejaranoi*. Also, *C. johnelsi* possesses humeral spines; these are absent in *C. bejaranoi*.

*Description*.—Adult males of moderate size for centrolenid frogs; SVL 23.8–24.4 mm ( $\bar{x} = 24.1$ ,  $n = 3$ ); females unknown. Head slightly wider than body; snout short, round in dorsal view, subtruncate in lateral view; canthus round and indistinct, loreal region slightly concave; lips not flared; nostrils nearly terminal on snout, not flared, directed laterally, internarial region concave. Eye moderately large, directed anterolaterally. Supratympanic fold obvious; lower three-fourths of tympanum visible, directed anterolaterally with slight posterior inclination. Prevomerine dentigerous processes and teeth absent; choanae oval; tongue broadly cordiform, slightly free posteriorly; short vocal slits present in males, extending from angle of jaw almost to midlateral edge of tongue.

Humeral spine absent; conspicuous dermal folds lacking; order of fingers from shortest to longest 1-2-4-3; webbing absent between first three fingers (Fig. 4); fingers lacking lateral fringes; finger discs broad, subtruncate; subarticular tubercles small, round, single; supernumerary tubercles absent; palmar tubercle moderately large, round, single; thenar tubercle elliptical.

Hind limbs slender; tibia length 53.3–56.6% of SVL; conspicuous tarsal fold absent; inner metatarsal tubercle small, flattened, elliptical; outer metatarsal tubercle absent; subarticular tubercles small, round; supernumerary

tubercles absent; toes about one-half webbed (Fig. 5); discs rounded to slightly truncate, smaller than those on fingers.

Skin on dorsal surfaces bearing spicules of heterogenous sizes; spicules present on upper eyelids and upper lip. Skin of belly and ventral thighs granular; chin, forelimbs, flanks, and shanks smooth. Anal opening directed posteriorly at upper level of thighs; anal tubercles and ornamentation absent.

*Color in preservative.*—Dorsal surfaces lavender with minute white spots, each white spot enclosing a large spicule. Ventral surfaces white or transparent.

*Color in life.*—Dorsal surfaces dark green with minute off-white spots. Digits orange-green; chest white; parietal peritoneum generally clear, that portion ventral to the heart is white; pericardial peritoneum covering ventral surface of the heart white; visceral peritoneum clear; bones and vocal sac pale green. Iris metallic yellow with black flecks.

*Distribution.*—This species is known only from the type locality in cloud forest of the Chapare region of the *yungas* of Bolivia (Fig. 1).

*Etymology.*—This species is named in honor of Professor Gastón Bejarano B., government official and naturalist, who encouraged and supported our work in Bolivia.

*Remarks.*—The stream where *C. bejaranoi* was collected is about 0.5 m wide; the stream bed consists of small rocks and gravel. The frogs were collected from heights of 1–2 m above the stream by night within 25 m of the road. This species was not observed to be calling.

Lynch and Duellman (1973) distinguished three patterns of peritoneal pigmentation among *Centrolenella*: 1) clear parietal, white visceral (*C. fleischmanni* and *pulverata* groups, and *C. albotunica*, *C. eurygnatha*, and *C. vanzolinii* of southeastern Brasil); 2) white parietal, clear visceral (*C. prosoblepon* group); and 3) white parietal, white visceral (*C. antioquiensis* and *C. resplendens*).

In the pattern of peritoneal pigmentation, as well as in other characters, *C. bejaranoi* fits most readily, though not clearly, in the *C. prosoblepon* group. The visceral peritoneum is without pigment; only a small portion of the parietal peritoneum, immediately ventral to the heart, is white. There may be intraspecific variation in the extent of the white pigment in centrolenid frogs, but such variation is not exhibited in the type series of *C. bejaranoi*.

*Centrolenella bergeri*, new species

Fig. 3

*Centrolenella munozorum* (partim)—Duellman, 1976, p. 2.

*Holotype.*—KU 182363, adult male, 24.8 mm SVL, from 58.1 km SW

Villa Tunari (by road), 1,980 m, Departamento Cochabamba, Bolivia (65°50'W, 17°11'S), obtained 21 January 1979, by Thomas J. Berger and David C. Cannatella.

*Paratypes*.—KU 182364–8, collected 21–22 January 1979, same locality and collectors as the holotype.

*Referred specimens*.—KU 162248–50, Perú:Cuzco:Río Cosñipata, 4 km SW Santa Isabel, 1,700 m. KU 162251–8, 162259–60 (eggs), Perú:Ayacucho:Tutumbaro, Río Piene, 1,840 m.

*Diagnosis*.—1) Prevomerine teeth absent; 2) bones white in life; 3) parietal peritoneum clear; visceral peritoneum white; 4) color in life pale yellow-green with diffuse yellow spots; color in preservative creamy white; 5) webbing formula of fingers III(2.25–2<sup>+</sup>)IV; 6) webbing formula of toes I(1.5–2<sup>-</sup>)II(1.5–2)III(1.25–2.5)IV(2.75–1.5)V; 7) snout round in dorsal view, subtruncate in lateral view; 8) dorsal skin shagreened; 9) forearm and tarsus lacking conspicuous dermal folds; 10) humeral spine absent in males; 11) tympanum concealed beneath skin, strongly oriented dorsolaterally.

Few Andean *Centrolenella* (*Centrolenella munozorum*, *C. pellucida*, and *C. fleischmanni*) are creamy white in preservative. *Centrolenella bergeri* differs from *munozorum* in the extent of webbing and relative size of the fingers (Fig. 4). *Centrolenella fleischmanni* has a visible tympanum; it is concealed in *C. bergeri*. *Centrolenella pellucida* has more extensive webbing on the hands and bears well-developed dermal folds on the limbs and below the anus (see remarks); *C. bergeri* lacks such dermal folds.

*Description*.—Adult males of moderate size for centrolenid frogs; SVL 22.7–26.5 mm ( $\bar{x}$  = 24.0,  $n$  = 13); females 23.2–26.3 mm ( $\bar{x}$  = 24.8,  $n$  = 2); A Mann-Whitney test between SVL's of males ( $n$  = 5) from Río Santa Isabel, Bolivia, and males ( $n$  = 7) from Río Piene, Perú, demonstrates that the samples are not different in SVL ( $0.3 > P > 0.2$ ). SVL is correlated with tibia length (Spearman rank correlation coefficient,  $r$  = 0.80;  $P < 0.001$ ); the mean ratio of tibia length/SVL equals 0.524,  $n$  = 12.

Head wider than body; snout short, round in dorsal view, subtruncate in lateral view; canthus round, indistinct, loreal region barely concave; lips not flared; nostrils nearly terminal, directed laterally; internarial region flat. Eyes large, protuberant, directed anterolaterally. Supratympanic fold absent; tympanum concealed beneath skin. Prevomerine dentigerous processes and teeth absent; choanae large, oval; tongue round, barely free posteriorly; short vocal slits present in males, extending from angle of jaw almost to midlateral border of tongue.

Humeral spine absent; conspicuous dermal folds lacking; order of fingers from shortest to longest 2-1-4-3; fingers slightly webbed (Fig. 4); finger discs moderately large, rounded; fingers with narrow lateral fringes; subarticular tubercles small, low; supernumerary tubercles absent; palmar tubercle indistinct.

Hind limbs slender; tibia length 52.4% (mean) of SVL; conspicuous dermal folds lacking; inner metatarsal tubercle small, ovoid; outer metatarsal tubercle absent; subarticular tubercles small, low; supernumerary tubercles absent; toes about three-fourths webbed (Fig. 5); discs on toes round, smaller than those on fingers.

Skin on dorsal surfaces of head and body shagreened; skin on venter granular; skin on other surfaces smooth; anal opening directed posteriorly at upper level of thighs; anal ornamentation and tubercles absent.

*Color in preservative.*—Dorsal surfaces creamy white with minute purple flecks (chromatophores); ventral skin transparent.

*Color in life.*—Dorsum pale green with diffuse yellow spots; venter and concealed surfaces without pigment; digits orange-yellow; parietal peritoneum clear, pericardial peritoneum clear; visceral peritoneum white, bones white. Iris metallic yellow-white with a few black flecks.

*Distribution.*—The species is known in Bolivia only from the type locality on the Amazonian slopes of Departamento Cochabamba (Fig. 1) and from two localities in cloud forest of the Cordillera Oriental in southern Perú (see maps in Duellman, 1976, 1978). The known elevational range of the species is 1,700–1,980 m. There is a gap of about 700 km between the Bolivian and Río Cosñipata (Perú) populations.

*Etymology.*—This species is named for Thomas J. Berger, who provided comic relief while securing part of the type series.

*Remarks.*—Duellman (1976) tentatively referred specimens from southern Perú to *Centrolenella munozorum*. He remarked that specimens from the Río Cosñipata and Río Piene have less webbing on the hands and feet and are larger than *C. munozorum* from Ecuador, differences of a magnitude usually seen between species of *Centrolenella* but perhaps representing clinal variation. Duellman also noted that the Ecuadorian and Peruvian populations were identical in coloration and lacked structural differences.

I have compared directly the holotype and most of the paratypes of *C. munozorum* with *C. bergeri* from Perú and Bolivia. In the former species the fingers are relatively much shorter and more fully webbed than those of the latter (compare Fig. 4A, this paper, with Fig. 3D, Lynch and Duellman, 1973). The samples from southern Perú and Bolivia exhibit no differences among themselves, but are substantially different from *C. munozorum*. Specimens of *C. munozorum* reported by Duellman (1976) and Tøft and Duellman (1979) from 200 m in Departamento Huánuco, Perú, are identical with the Ecuadorian *C. munozorum*.

*Centrolenella bergeri* is most similar to *C. pellucida*, from the Amazonian versant of Ecuador. The two species agree closely in many characters; *C. pellucida* has more webbing on the hands and feet than does *C. bergeri*, but the proportions of the hands and feet are quite similar. The species are identical in coloration. One of the diagnostic features of *C. pellucida*—



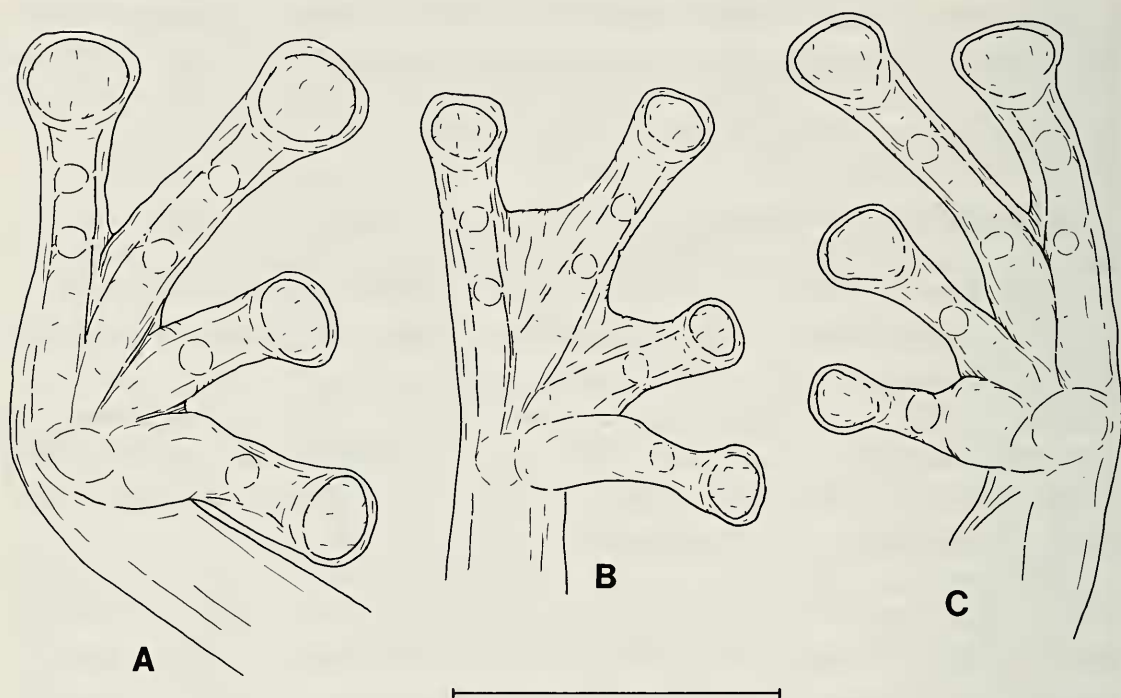


Fig. 4. Palmar view of hands: A, *Centrolenella bergeri*, paratype, KU 182366; B, *Centrolenella pellucida*, holotype, KU 143298; C, *Centrolenella bejaranoi*, paratype, KU 182371. Line equals 5 mm.

known only from the holotype—is an unscalloped dermal fold on the outer edge of the hand and forearm, and on the foot and tarsus; a second character is a transverse dermal fold below the anus (Lynch and Duellman, 1973). Having examined the holotype of *C. pellucida* (KU 143298), I believe that the subanal dermal fold represents a preservation artifact. The dermal folds along the limbs also may be due partly to preservation.

The holotype of *C. pellucida* is a gravid female, SVL 22.0 mm. This is smaller than the smallest male (22.7 mm) and female, also gravid, (23.2 mm) of *C. bergeri*.

*Centrolenella bergeri* obviously belongs to the group of species—*C. fleischmanni*, *C. munozeum*, and *C. pellucida*—that has white bones in life, white visceral peritoneum, clear parietal peritoneum, white ground color in preservative, and lacks prevomerine teeth and dentigerous processes, humeral spines, subanal tubercles, and distinct canthi (Lynch and Duellman, 1973). The southernmost reported locality of *C. fleischmanni* is Quevedo, Pacific lowlands of Ecuador (Noble, 1924). The lowland species *C. munozeum* ranges south to the Río Lullapichis in central Perú (Toft and Duellman, 1979). *Centrolenella pellucida* is known only from the cloud forest of the Río Coca drainage of the Amazonian slopes of Ecuador. No members of the group are known from the cloud forests of southern Ecuador and

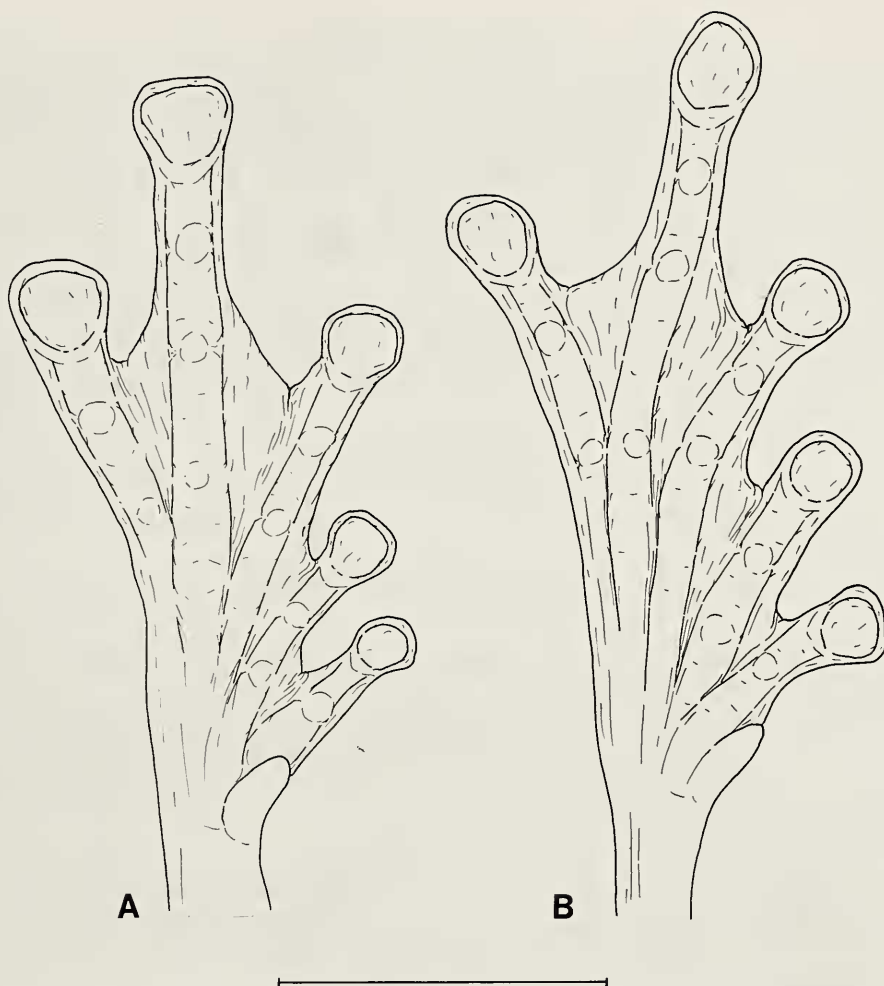


Fig. 5. Plantar view of feet: A, *Centrolenella bejaranoi*, holotype, KU 182369; B, *Centrolenella bergeri*, paratype, KU 182366. Line equals 5 mm.

northern Peru; a gap of about 1,500 km airline separates the closest records of *C. pellucida* and *C. bergeri*.

*Life history notes.*— Several of the males of the type series were observed calling from the undersides of leaves 1–3 m above the stream at night. KU 182364 called from the underside of a leaf while sitting about 4 cm from an egg clutch (KU 182372). The egg clutch consists of 29 embryos at Stage 18 (Gosner, 1960), arranged in a monolayer on the underside of the leaf, not hanging from the leaf tip. In life, the jelly is clear and the embryos are pale green (Fig. 2). Duellman (1976) commented on a male calling adjacent to a clutch of 25 eggs at the Río Piene in Perú. *Centrolenella bergeri* and *C. bejaranoi* were taken at the same stream in Bolivia. At the Río Cosñipata in Peru, *C. bergeri* was found with *C. spiculata*, *C. truebae*, and a specimen referred to *C. ocellata*. At the Río Piene *C. bergeri* occurred with specimens referred to *C. siren* (Duellman, 1976).

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